GEOLOGY FIELD GUIDEBOOK

JACKSON, LENAWEE AND WASHTENAW COUNTIES, MICHIGAN

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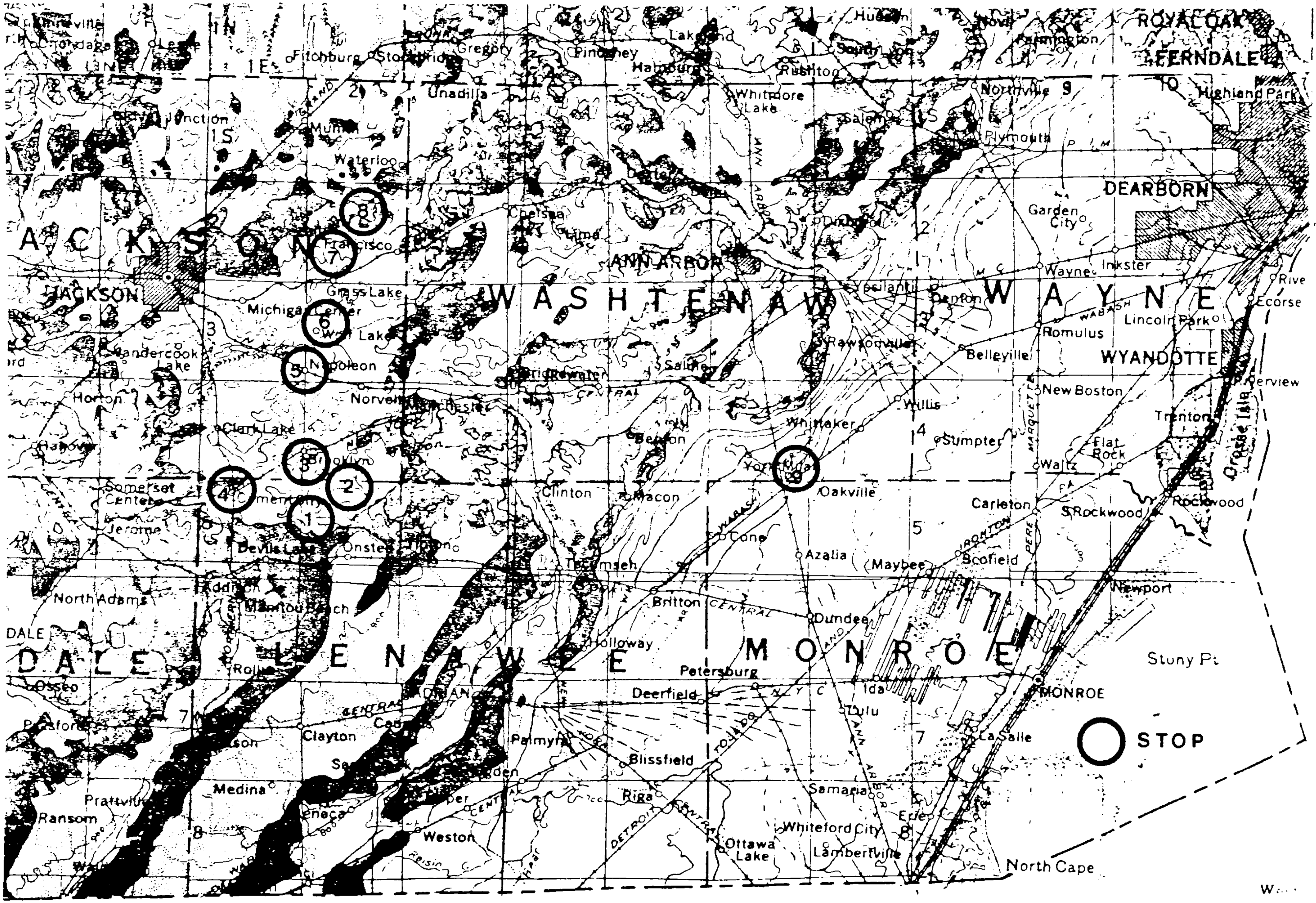
This field trip is adapted from the University of Toledo glacial geology field trip compiled by William A. Kneller, Professor of Geology



STOP
ROYAL OAK
FERNDALE
Highland Park
DEARBORN
Northville
Plymouth
Garden City
Wayne
Inkster
Ecorse
Lincoln Park
WYANDOTTE
Romulus
Belleville
New Boston
Trenton
Flat Rock
Rockwood
Carleton
Newport
MONROE
Stony Pt
La Salle
North Cape
Whitmore Lake
Salem
Dixboro
Ypsilanti
Denton
Rawsonville
Willis
Whittaker
Sumpter
Waltz
Milan
Oakville
Azalia
Maybee
Scofield
Dundee
Ida
Lulu
Petersburg
Deerfield
Blissfield
Samaria
Erie
Whiteford City
Lambertville
Ottawa Lake
Riga
Palmyra
Weston
Clayton
Medina
Prattville
Ransom
Tecumseh
Britton
Holloway
Clinton
Macon
Cone
Saline
Bridgewater
Chelsea
Lima
ANN ARBOR
Unadilla
Gregory
Pinckney
Hamburg
Lakeland
Rushton
Fitchburg
Munith
Waterloo
Francisco
Grass Lake
Michigan Center
Napoleon
Norvell
JACKSON
Vandercook Lake
Horton
Clark Lake
Brooklyn
Somerset Center
Jerome
Devils Lake
Onsted
North Adams
Manitou Beach
Osseo
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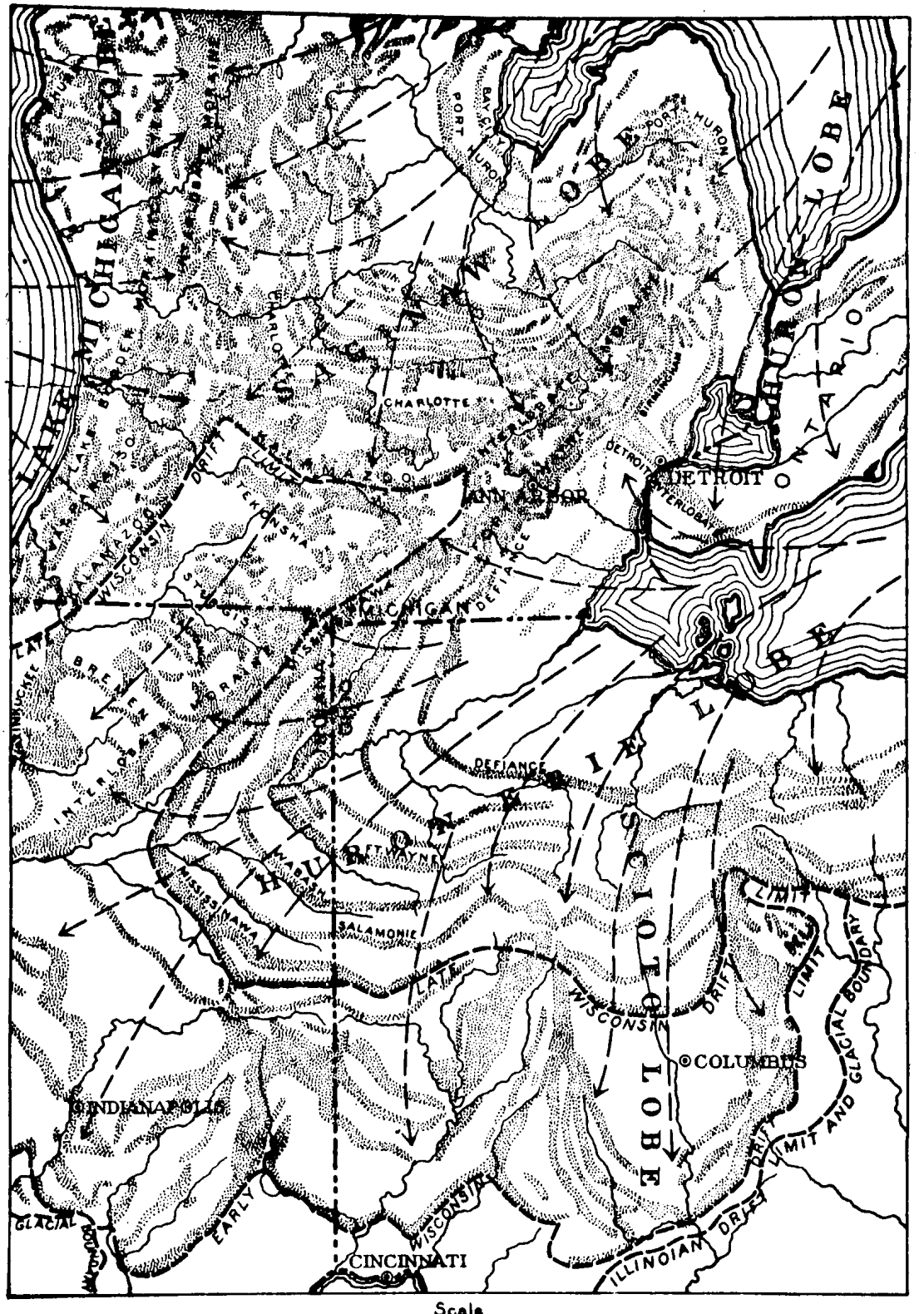
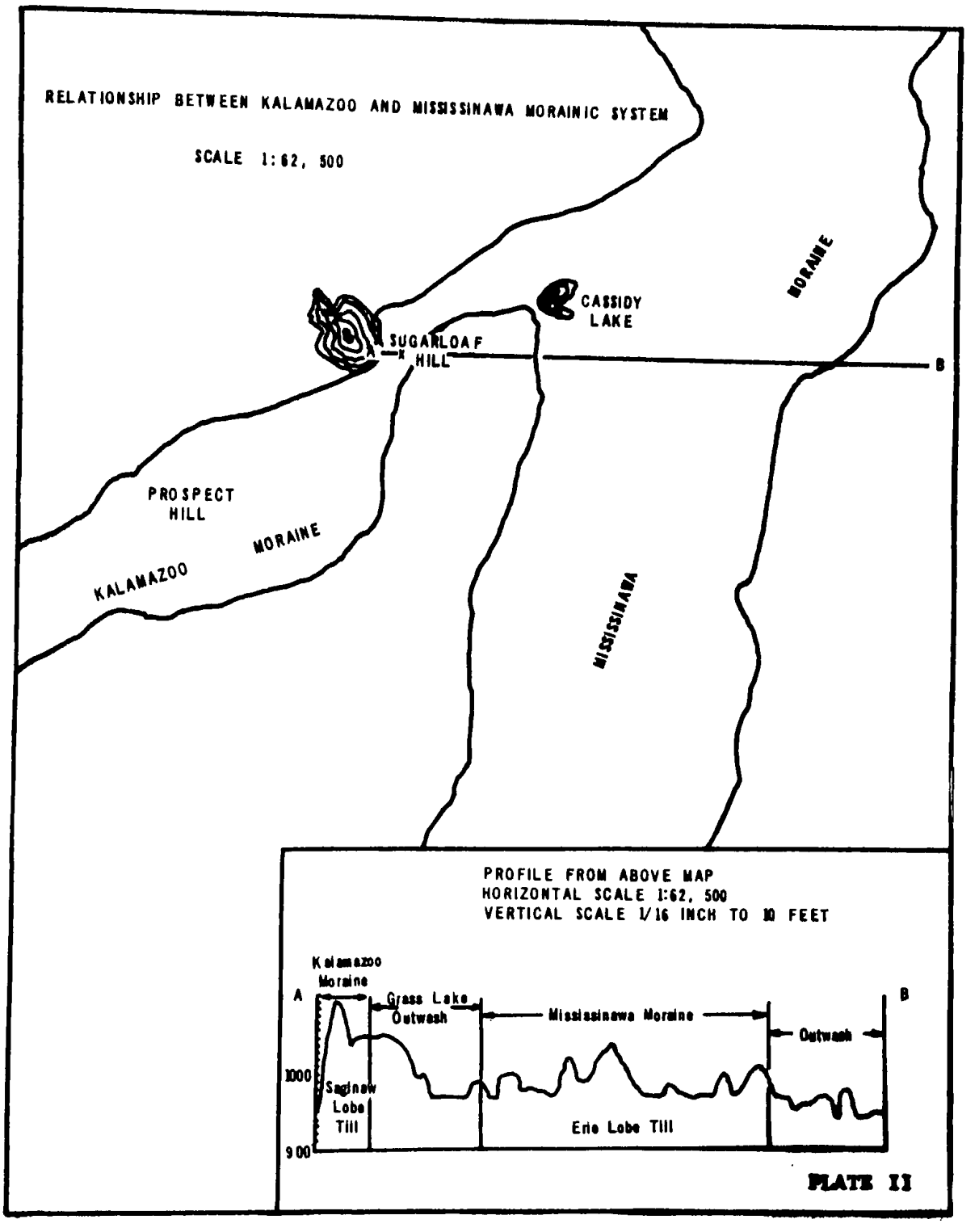


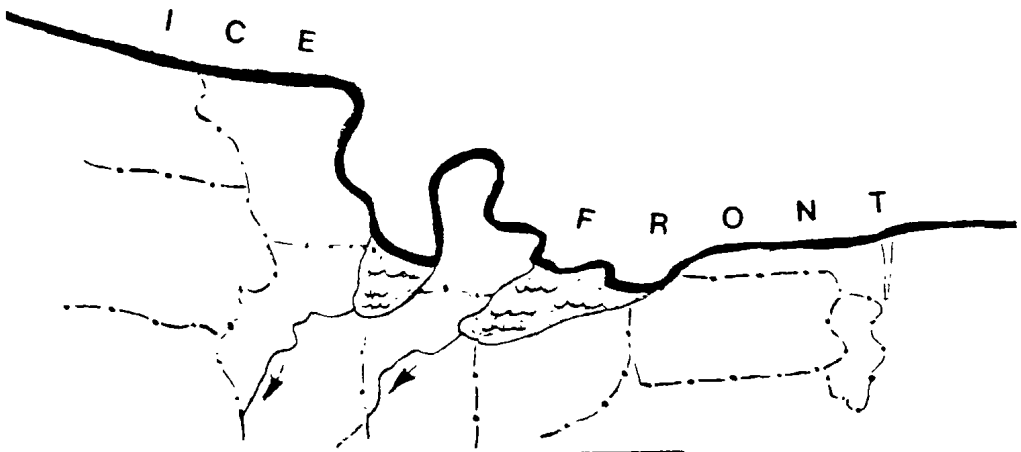
PLATE I

Glacial Moraines in Southern Michigan and Portions of Adjacent States. The direction of ice movement of the different lobes is indicated by arrows and the limits of the ice at different stages by heavy dashed lines. (After Leverett and Taylor, (1915). The Pleistocene of Indiana and Michigan and the History of the Great Lakes. U.S.G.S. Monograph LIII, Plate V, p. 62.)


RELATIONSHIP BETWEEN KALAMAZOO AND MISSISSINAWA MORAINIC SYSTEM
SCALE 1:62, 500
CASSIDY LAKE
SUGARLOAF HILL
A
B
MORAINE
PROSPECT HILL
MORAINE
KALAMAZOO
MISSISSINAWA
PROFILE FROM ABOVE MAP
HORIZONTAL SCALE 1:62, 500
VERTICAL SCALE 1/16 INCH TO 10 FEET
Kalamazoo Moraine
Grass Lake Outwash
Mississinewa Moraine
Outwash
1000
900
Saginaw Lobe Till
Erie Lobe Till
PLATE II

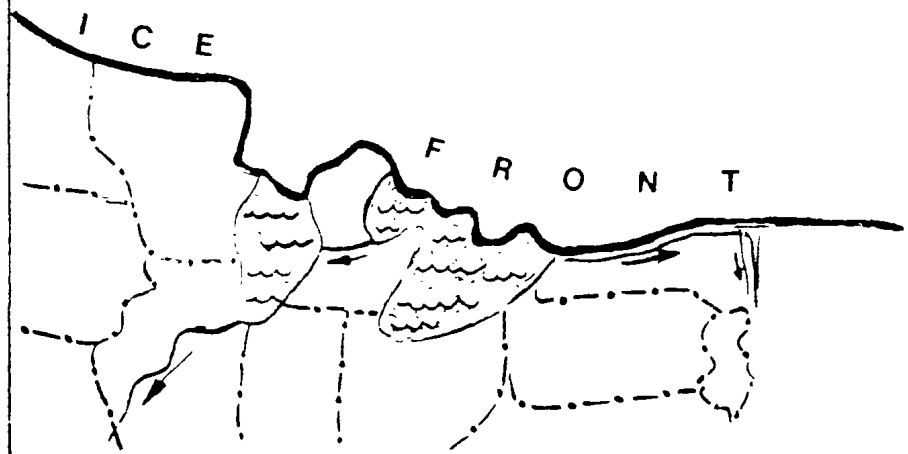
Great Lakes Region During Various Stages of Glacial Retreat And Advance

Early Lake Chicago & Lake Maumee occurring during temporary glacial retreat between the Fort Wayne advance and the Defiance advance.

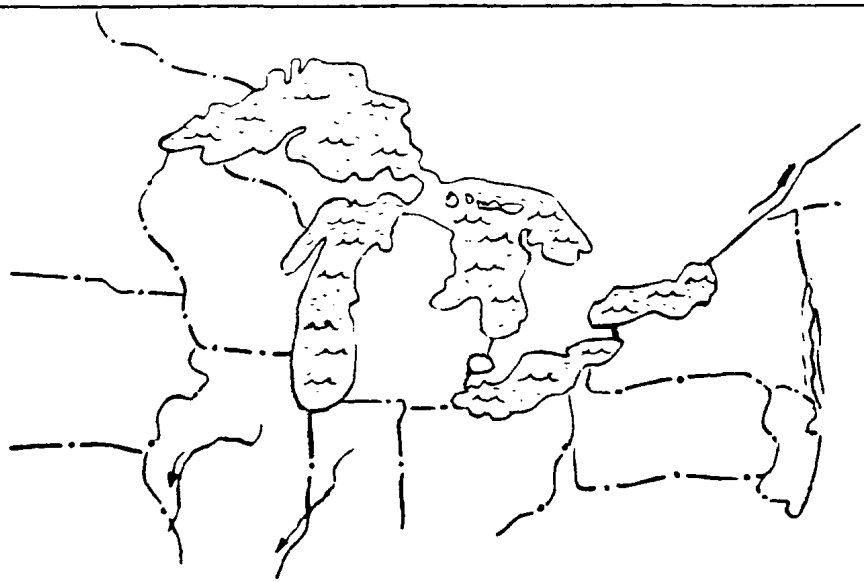


1.) Highest Lake Maumee 800'
Early Lake Chicago
Drainage Southwest

Lake Chicago (Glenwood Stage I) and Lake Arkona occurring during temporary glacial retreat between the Lake Border advance and the Port Huron advance

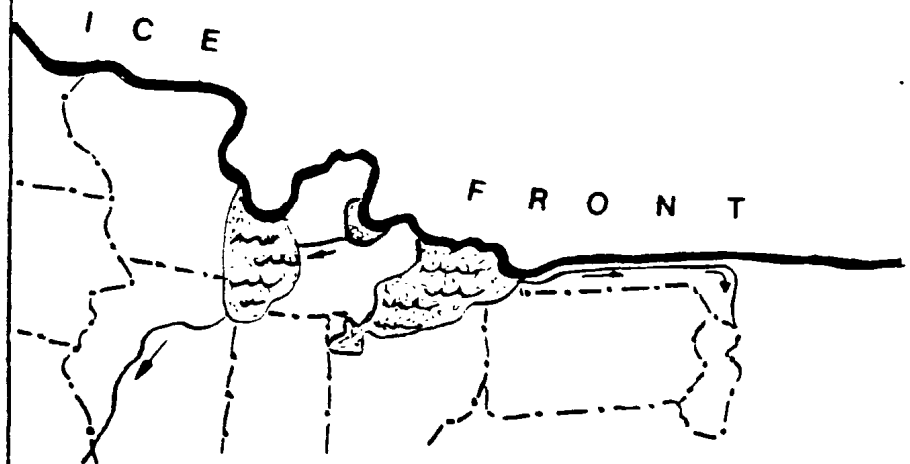


2.) Lake Arkona 710'-695'
Lake Chicago (Glenwood Stage I) 640'
Drainage Southwest and East



4.) Present Great Lakes Area
Natural Drainage Northeast

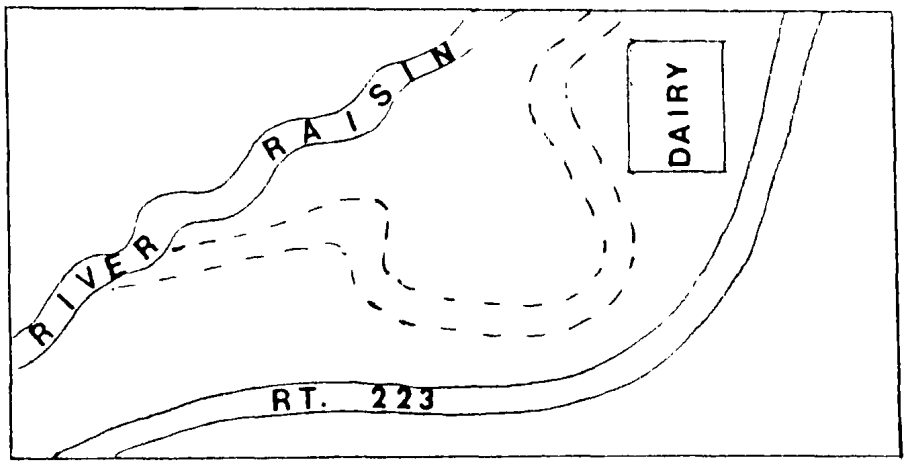
Lake Chicago (Glenwood Stage II) and Lake Whittlesey occurring at the time of maximum extent of the Port Huron advance.



3.) Lake Whittlesey 738'
Lake Chicago (Glenwood Stage II) 640'
Drainage Southwest and East

DISTANCE FROM LAST ENTRY	ACCUMULATED MILEAGE	DESCRIPTION
		Leave the University of Toledo on Secor, proceed on Secor to Monroe Street, proceed to Main Street intersection in Sylvania.
		Sylvania, Ohio Turn right (north), proceed on Main Street.
0.0	0.0	Ohio-Michigan State Line Notice the very flat topographic surface. This surface is called a lake plain. The plain once formed the bottom of a pro-glacial lake called Lake Warren. The soil is a very fine sandy loam phase of the Lucas silt-loam series of Northwestern Ohio.
3.1	3.1	Hamlet of Ottawa Lake. This hamlet is near the southern edge of a drained intermittent lake. The soils of this area belong to the Brookston, Blount, Hoytville, Toledo and Colwood series of the gray-brown podzolic great soil group. The parent material is calcareous (limy). These soil associations range from silty clay to clay loams.
1.4	4.5	Bed of intermittent Ottawa Lake to right.
1.1	5.6	Junction with Rt. 223 - Turn left
2.7	8.3	Detroit, Toledo and Ironton R.R. underpass.
1.9	10.2	Note cemetery on hill to far left. This zone is at 695 feet A.T. and represents the lowest Lake Arkona beach. Lake Arkona was one of the ancestral lakes of Lake Erie. This beach represents a retreat of the ice to the East. Lake Arkona produced beaches which are now very discontinuous and indistinct. The obscurity of the beaches is attributed to the fact that the outlet of the lake was continuously being eroded during its use, thus slowly lowering lake level and producing only poorly defined beaches at several elevations from 695 feet A.T. to 710 feet A.T.
0.9	11.1	Railroad crossing near Blissfield, Michigan village limits - Note rapid change in soil coloration. The soils of this area are formed on level and gentle undulating surfaces. They are imperfectly and poorly drained soils developed in deltaic and lacustrine deposits. The soils range from sandy loams to sandy clay loams.
0.8	11.9	Bridge over River Raisin.

F.L.E.	A.M.	DESCRIPTION
1.0	12.9	Near junction with Wellsville Hwy. Note: Sandy zone in ridge to left. Lowest Lake Arkona Beach. 695 feet A.T. From this location to the village of Palmyra, we begin to ascend on the delta of Lake Whittlesey.
2.2	15.1	Junction with the Crockett Hwy. Very sandy area. We are now well situated on the delta.
0.6	15.7	SLOW DOWN Note the abandoned meander channel of the River Raisin located to the left and on the inside of the highway (Rt. 223) curve.



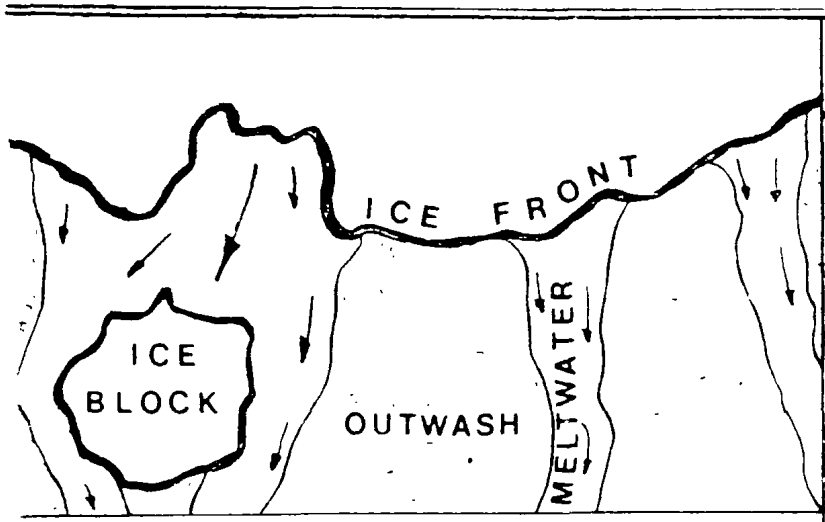
Palmyra village limit. The apex of the Lake Whittlesey delta lies approximately 2-3/4 miles to the right front (northwest) of Palmyra near the junction of Adrian-Deerfield Rd. with Humphrey Hwy., at an elevation of 738 feet A.T.

0.8	16.5	River Raisin
1.3	17.8	Junction with Meyers Hwy.
0.9	18.7	The gentle rise of the land to the front near the junction with Humphrey Hwy. identifies the Lake Whittlesey beach at an elevation of 735 feet A.T. A major readvance of the glacier buried the older Arkona outlet with ice and altered the drainage back to the Ubly Channel to the Grand River, across central Michigan. This readvance formed the new ancestral Lake Erie, called Lake Whittlesey. The

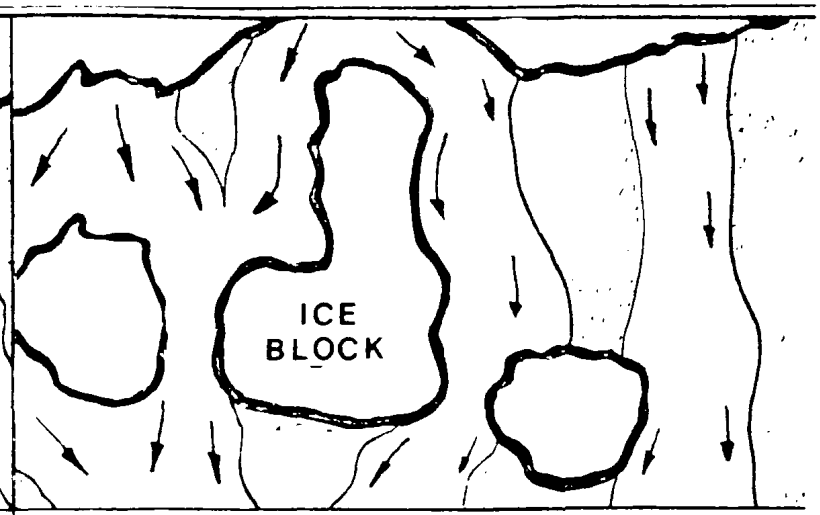
D.F.L.E.	A.M.	DESCRIPTION
		beaches associated with this new lake have an elevation of 735 feet A.T. In general, the beaches of Lake Whittlesey are the highest and most prominent of all the pro-glacial lake beaches of Ohio and Michigan. Their height and steepness increase to the east, apparent because in this part of the basin, the fetch (extent of open water over which the wind blows) was greater, with the prevailing westerly winds, thus producing larger beaches. Near Ashtabula, Ohio, the Whittlesey beaches are only 10 to 15 feet high.
0.8	19.5	Ground moraine - typical swell and swale topography. To front is the Defiance end moraine.
0.1	19.6	Note to the left a small sand borrow pit. This may represent one of the Lake Maumee beach levels.
0.4	20.0	You are now on the Defiance moraine. The soils that are developed at this locality are limy, clay-loams, silty clay loams and clays. Typical soil series of this area are the Morley, Blount, St. Clair and Nappanee series which developed on undulating and rolling hills. The Defiance moraine runs northeastward from Ohio-Michigan line past Adrian, Tecumseh, Saline, Ypsilanti, Northville and Amy to the Clinton River a few miles east of Pontiac. Near the Ohio-Michigan state line the moraine changes from a smooth water-laid ridge to a gently rolling undulating land-laid moraine at Adrian. The Defiance moraine has highest Maumee beaches on both sides of it. These attest to the fact that it is a water-laid moraine.
2.1	22.1	Junction of Rt. 223 with Rt. 52. You are now descending the eastern edge of a major meltwater channel. The present course of the Huron River is eastward to Lake Erie. During Defiance time, the ice and its associated moraine blocked the drainage of the Huron River, diverting the course of the river to the south and southwest. In the vicinity of Adrian, the "old" course of the Huron River drained into highest Lake Maumee (800 feet A.T.) which partially inundated the morainic ridge on the east and on the west. This feature is termed a glacial sluiceway because it received a major part of the meltwater formed at that time. The soil associations of this area are the Fox, Bronson and Oshtemo series. They form level to gently rolling well-drained soils developed from sandy loam and loamy sand overlying sand and gravel.
0.6	22.7	Bridge over River Raisin. This point is located in the center of the glacial sluiceway.
0.4	23.1	Highest Maumee Beach. 800 feet A.T. This beach represents the water plane of the first pro-glacial lake that came into existence when the ice front had receded far enough to the north so that a basin was uncovered which was blocked to the north by the ice and the high ground to the west and south. This lake is identified by beaches which occur at an elevation of 800 feet A.T. Drainage from the lake was to the west through Indiana to the Mississippi River by

D.F.L.E.	A.M.	DESCRIPTION
		way of the Maumee and Wabash Rivers. The approximate dates for the age of Highest Lake Maumee range from 14,500 to 15,200 years B.P.
0.5	23.6	Junction with Rt. 34, and overpass. This point marks the position of gravel and sand terraces that are associated with the glacial sluiceway mentioned above. To the front, you are rising on the Fort Wayne moraine.
0.5	24.1	Adrian College to the right - Ground moraine.
0.8	24.9	Junction with Business Rt. 223, bear left. You are still on ground moraine.
0.7	25.6	You are now rising on a satellite end moraine ridge of the Fort Wayne morainic system.
1.2	26.8	Wolf Creek
1.7	28.5	The surface represented at this point is classical swell and swale topography or ground moraine.
0.7	29.2	Starting at the intersection of Rt. 223 with Hoddinett Hwy. persisting for approximately one and one-half miles along Rt. 223 to the intersection with Springville Hwy. (30.7 accum. miles) the soil association and the topography changes. The surface is nearly level and is imperfectly and poorly drained. The soil association between these two points include the Blount, Pewamo and Nappanee series. These series are developed from clay loams, silty clay loams and clays associated with till plains and gently rolling ground moraines.
1.5	30.7	Jct. with Springville Hwy.
		SLOW DOWN
0.1	30.8	To the left there is an entrenched stream valley with several stream terraces. The present stream does not have the potential energy to do this amount of work. This present low capacity of the stream suggests a change in the streams regime. Change in climate, lowering of the water table may in part, explain the decrease in the "might" of this stream.
2.5	33.3	Junction with Brooks Hwy. You are now rising on the Wabash moraine.
0.6	33.9	The soils of this area are developed on rolling to very hilly topography. They are well-drained loamy sands and sandy loams which include the Hillsdale, Spinks, Fox, Oshtemo, and Boyer soil series. This series is commonly associated with glacio-fluvial deposits such as kames, outwash plains, eskers, crevasse fillings, etc.
1.4	35.3	Just past the white church on the right side of the road there is outwash (sand) which is capped by about 4 to 6 feet of till. This represents a readvance of the ice over meltwater deposits. This outwash was derived from meltwater of the Saginaw ice lobe. The Saginaw ice withdrew from the area, and the Erie lobe ice advanced over the earlier Saginaw outwash. Note the similarity of this topographic

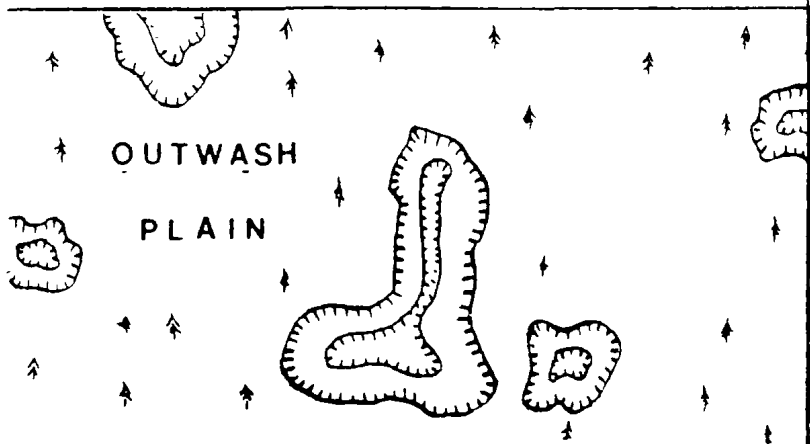
DIAGRAMMATIC SEQUENCE OF THE FORMATION OF PITTED OUTWASH LAKES



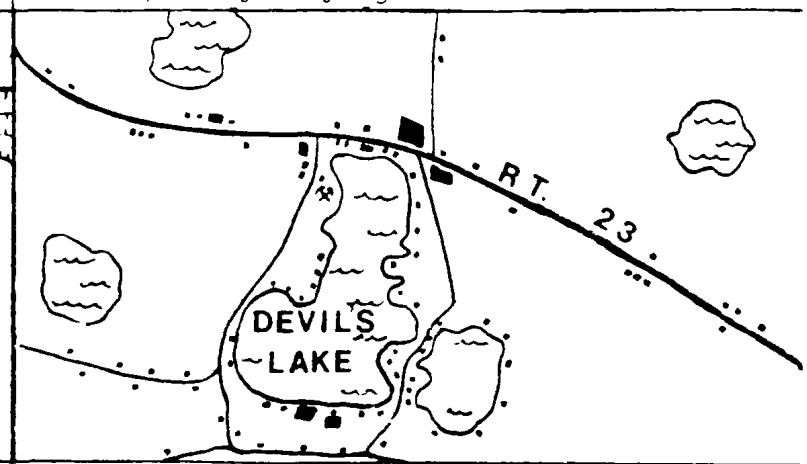
1) Ice blocks break away from glacier - carried into outwash plain by meltwater streams.



2) Blocks become grounded - Streams build up outwash deposits around blocks, completely burying some.



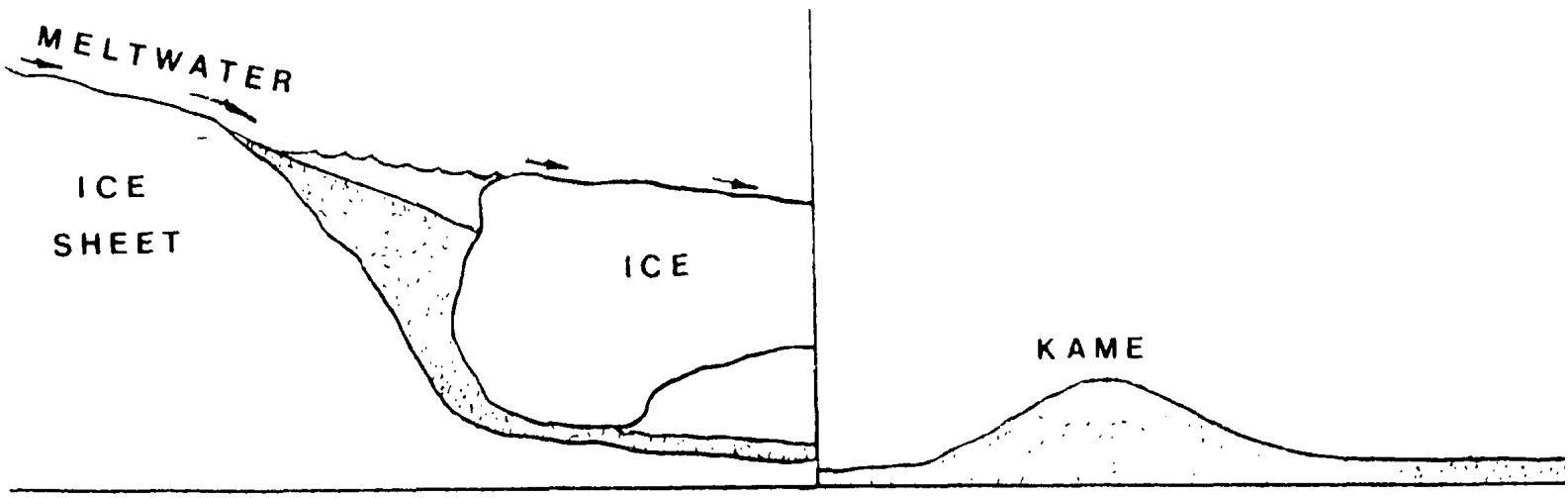
3) After blocks melt, depressions dot the outwash plain.



4) Rain and natural drainage fill the depressions forming lakes.

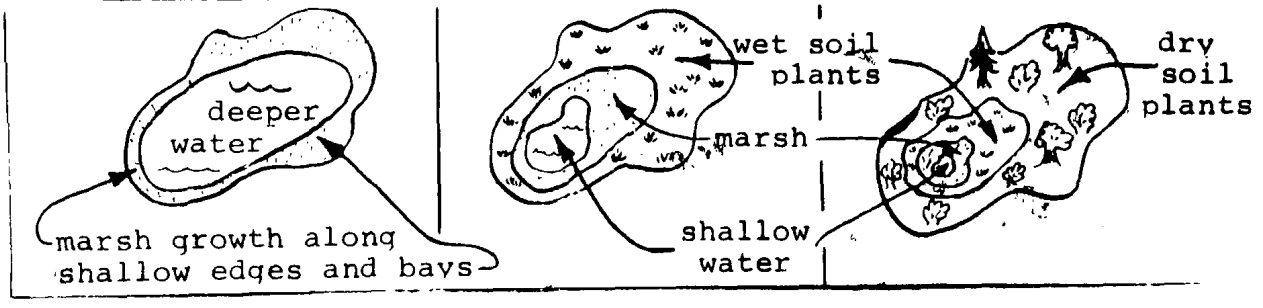
D.F.L.E.	A.M.	DESCRIPTION
		surface to ground moraine. The accordant summits and the stratified deposits help to classify these deposits as a slumped and pitted outwash plain. This slumped topography is typical of a stagnant ice condition.
3.0	38.3	Devils Lake to the left front. Devils Lake is an ice block lake formed in a pitted outwash plain. The separation of stagnant ice blocks from the main mass of a retreating glacier and its partial or complete burial by outwash causes a basin to form after the trapped ice melts. If the basin is bottomed by till or the water table intersects the depression, it will fill up and form a lake similar to Devils Lake.
0.1	38.4	Turn right on Round Lake Hwy. Large ridge of stratified drift to the right front.

KAME FORMATION HYPOTHESIS: 1) Meltwater gushed down a crevasse carrying sand, gravel, and rocks - the passage became blocked and deposits built up as an inverted cone, 2) As the glacier melts, deposits slump leaving a conical hill - Moulin Kame.



1.2	39.6	To your right is the Lenawee County Road Commission pit. It is located in a large Moulin kame which is part of a ridge of stratified

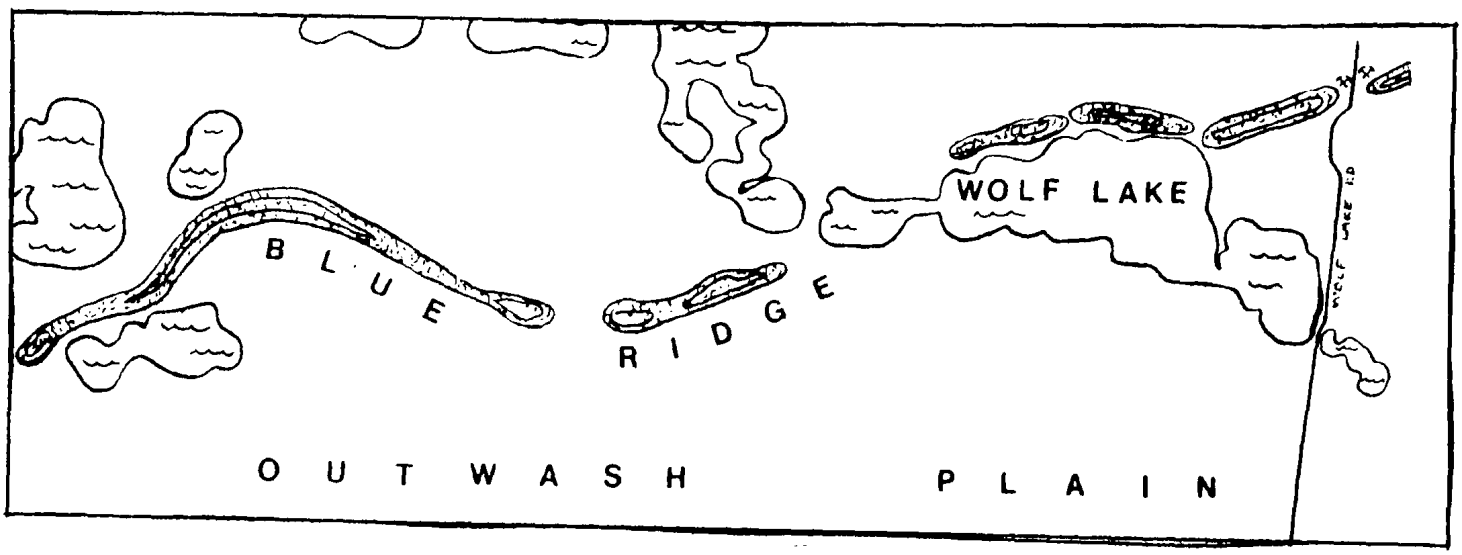
D.F.L.E.	A.M.	DESCRIPTION
		drift. THEORIES: (1) the ridge constitutes an interlobate morainic system formed in a re-entrant between two lobes, or (2) large ice channel fillings. The latter hypothesis seems more plausible. Ice channel fillings form when the ice thins and the surface drainage is guided along glacial crevasses, in which glacio-fluvial material, together with minor bodies of till, are deposited. On ultimate melting of the ice, these fillings become ridges.
0.7	40.3	Junction with Vischer Hwy. - turn right.
0.5	40.8	Turn left on Prospect Hill Rd. STOP NO.1 - A large ridge of stratified drift and a kame field is present to right of the road. A brief stop will be made.
1.3	42.1	Kettle hole (Ice block depression) to the left. At road junction, bear right.
1.7	43.8	STOP NO. 2 - BUENA VISTA POINT Look to the left. To your direct front you are viewing a large outwash plain with associated ice block lakes. To the far front (directly east) and to the right front are the morainic ridges of the Erie ice lobe. To the northeast (your left front) is the ground moraine located at, and just west of, Brooklyn, Michigan.
0.3	44.1	Bear left on Laird Hwy. Follow Laird Hwy. over pitted outwash plain to M-50.
0.7	44.8	To your left is a lake obliterated by vegetal growth. (Hydroseric succession.)



1.7	46.5	Junction with Rt. 50. Turn left on Rt. 50
0.2	46.7	STOP NO. 3 - Turn left into abandoned gravel pit. The stratigraphic section exposed in this pit exhibits well developed crossbedding, graded bedding, slump structures and meltwater channel deposits.
0.7	47.4	Junction with Rt. 12. Turn left.
5.5	52.9	Turn right on Cement City Hwy. (just east of railroad overpass).
0.8	53.7	STOP NO. 4 - Goose Lake Marl Deposit. This lake is located along an interlobate moraine of the Saginaw and Erie Lobes in an area of outwash deposits. Goose Lake is a typical ice block lake.

D.F.L.E.	A.M.	DESCRIPTION
		A stratigraphic section at this locality exposes humic sediments underlain by a gray shell marl. The marl was dredged and used to manufacture Portland cement for many years by the Peninsula Portland Cement Co. (ruins of this plant still remain).
		Continue north on Cement City Hwy.
1.7	55.4	Turn right on Vicary Road (Cement City Road)
1.5	56.9	Jct. with Taylor Road. Turn left on Cement City Road, winding road.
3.6	60.5	Turn right on Jefferson Road in Brooklyn
0.2	60.7	Turn left on Rt. 50.
0.5	61.2	Junction with Riverside Rd. This point marks the location of a major meltwater channel which flowed southwestward and drained the Wolf Lake and Grass Lake outwash plain complexes.
1.1	62.3	Junction with Crego Rd. - Ground moraine.
1.3	63.6	Junction with Chicago Rd. - Outwash plain. Note the small sand borrow pit to right about .2 miles from this intersection.
0.3	63.9	Village limits of Napoleon.
0.4	64.3	Junction of Rt. 50 with Austin Rd. Turn right.
0.4	64.7	STOP NO. 5 - Judes Stone Quarry. The Napoleon Sandstone Member of the Marshall Formation in Jude's Stone Quarry is a tan to buff, medium-grained, moderately well-sorted, crossbedded, unfossiliferous quartz sandstone. Both planar and trough crossbed sets are present. Crossbed dips are predominantly to the southwest. The thickness of the crossbed sets decreases towards the top of the unit, ranging from 8.5 feet in the lower portion to less than a foot near the top. On the upper portion of the unit 'rippled toroids' are common. This unique sedimentary structure occurs as large, doughnut-shaped sandstone casts which are characterized by a central depression with radiating ripple mark-like ridges.
0.7	65.4	Turn left at Sharon Valley Rd.
0.4	65.8	Turn left at Wolf Lake Rd. You are now looking at a pitted outwash plain. This plain is the southern extension of the Wolf Lake-Grass Lake outwash plains. This outwash plain was deposited by the melt waters associated with the Erie lobe ice that formed the Mississinewa Moraine and the Saginaw lobe ice that formed the Kalamazoo moraine. A careful inspection of topographic maps would reveal that the summits of the swells have trends southwestward, the size of the sands and gravels decreasing in the same direction. These outwash plains are pitted due to partly buried ice blocks collapsed or slumped into the holes. The summits of these swells are nearly accordant and are capped with sands and gravels. This helps identify the area as a pitted outwash plain rather than ground moraine.

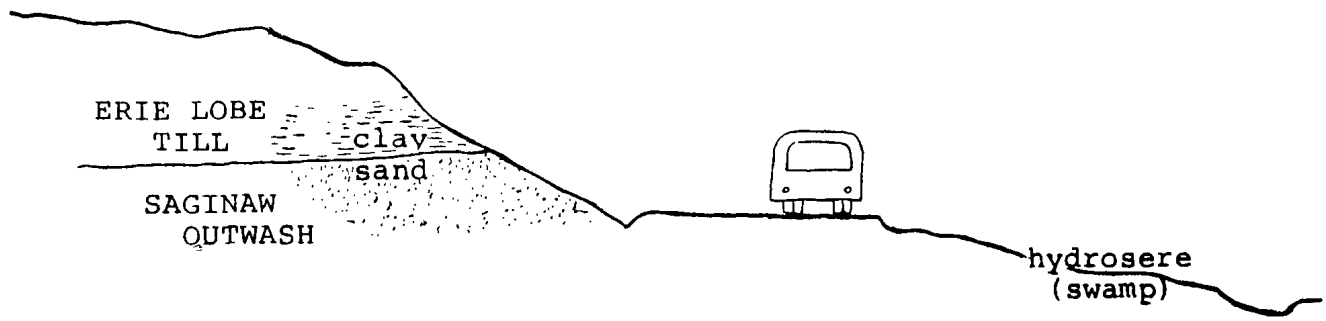
D.F.L.E.	A.M.	DESCRIPTION
1.6	67.4	Note: Stand of Tamarack (Eastern Larch) to the right bordering the hydrosere. Wolf Lake is to the left. LUNCH STOP: Little Wolf Lake County Park
1.2	68.6	STOP NO. 6 - Wolf Lake Esker or crevasse filling. Road cuts across this feature.



1.9	70.5	The flat topography you are looking at is more typical of a non-pitted outwash plain (Grass Lake outwash plain.)
2.4	72.9	Junction with W. Michigan - Turn right to S. Union St. Also, Grass Lake Village limits.
0.8	73.7	Turn left (north) on S. Union St.
3.7	77.4	STOP NO. 7 - Geographic relationship between the Kalamazoo and Mississinewa morainic Systems. Turn west (left) into parking lot at the foot of Sackrider Hill. The short walk to the crest of the hill is well worth the effort. This is a classical moulin kame. A moulin is a circular tube-like crevasse in a glacier. Meltwater upon the surface of the glacier plunges down the tube-like crevasse depositing sands and gravels upon the floor, which forms an irregular shaped mass. After the ice melts, slumpage occurs modifying the original shape to that of a conical shaped hill. The elevation of the moulin kame is 1100 feet. The kame terrace at 1050 feet is visible to the south. The Kalamazoo morainic complex extends to the northeast and southwest. To the east trending north-south is the Mississinewa moraine. Note that much of the Kalamazoo morainic complex is more rugged than the Mississinewa. (See Profile, PLATE II) Just north of Sackrider Hill are well developed kettle holes. After returning to the parking lot, con-inue northward through the kame moraine. Note change in vegetation between topographic highs of well drained sand and poorly drained depressions. Note several exposures of soil profiles along road cuts.

D.F.L.E.	A.M.	DESCRIPTION
1.6	79.0	Turn east (right) on Seymour Road. Extension of lake being filled by vegetation to the south (right).
0.3	79.3	Lakes are slowly filled and obliterated by plant growth. This is one of the many excellent examples of hydroseric succession in this area.
1.9	81.2	STOP NO. 8 - Turn left on gravel road and park along edge of road. Abandoned gravel pit exhibiting ledges of cemented gravels. The origin of the cemented gravels - sometimes called natural concrete - may be explained as the result of a variable water table which percolates water through the limestone bearing gravels and partially dissolves the lime. The further downward migration of the lime-rich water continues until favorable conditions result in the precipitation of the lime and the gravel is then cemented in the lower portion.
0.8	82.0	Return to Seymour Rd., turn left, BE CAREFUL ! Gravel pit to left.
0.7	82.7	STOP SIGN AHEAD ! Turn south (right) on Clear Lake Road.
1.2	83.9	Kame fields on both sides of the road. Note the ridge-like topographic feature to the west (right) beside Locker Lake. This feature is probably a crevasse filling which was deposited between large blocks of ice occupying Locker and Pond Lily Lakes to the south and east.
0.4	84.3	Note sand pit to left. Turn left (east) on Harvey Road.
0.2	84.5	Pond Lily Lake on the left (north).
0.8	85.3	Turn left (north) on Loveland Road (Notter Road). Note the old gravel pit on the northeast corner of the intersection.
0.1	85.4	Observe to the northwest (left front) the uneven surface which is the result of a complex system of kame deposits.
0.6	86.0	Large gravel pit operation on the west (left). Note cobble piles.
0.1	86.1	We are now ascending a kame moraine, probably correlated with the Kalamazoo moraine of the Saginaw Ice Lobe.
0.1	86.2	Note the old, abandoned cemetery on the left. This area was once heavily settled by early 19th Century farmers. Modern agricultural conditions have resulted in a change of land use.
1.1	87.3	Bear left at road intersection and continue north.
1.1	88.4	To the west (left) of the road are ice block depressions.
0.3	88.7	Bear east (right) on McClure Road.
0.8	89.5	Sylvan Lake Trout Pond.
0.2	89.7	Crooked Lake fishing site Road.

).F.L.E.	A.M.	DESCRIPTION
).4	90.1	Ranger Headquarters -- Waterloo Recreation Area. Here one can walk up the nature trail to Sugarloaf Hill, a kame similar in expression and origin to that of Sackrider Hill. A short distance east of the Ranger Headquarters is a relatively flat area which is an outwash plain. To the northeast the ridge of the Mississinewa moraine complex can be observed. We are now near the junction of the two moraines. This area also exhibits a re-entrant angle between the Saginaw and Erie Ice Lobes
0.8	90.9	Mill Lake fishing site is to the south (right). A moulin kame may be seen to the north (left). Another esker can be seen extending south along the right (west) side of the Mill Lake fishing site road.
).3	91.2	Turn right along Bush Road.
1.5	92.7	Turn south (right) on Pierce Road.
0.3	93.0	Relationship between Erie Lobe Till and Saginaw Lobe outwash. The road cuts in this area show the till-outwash relationships between these two ice sources. The glacio-fluvial material beneath is from the Saginaw outwash while the till at the surface represents the later advance of the Erie ice over this area. The farthest advance of the Erie Lobe appears to be a short distance west of this point.



0.9	93.9	Turn east (left) on Cavanaugh Road.
1.9	95.8	Enter village of Chelsea - proceed east on W. Middle St. to Main St. Turn right on Main St.
1.8	97.6	Overpass of Interstate 94. Follow I-94 east (Ann Arbor).
2.5	100.1	Fletcher Rd. exit.
0.9	101.0	Lima esker deposit, this feature has just about disappeared due to gravel and sand removal.
		The terrain is typical interlobate morainic topography. Meltwater deposits occur in Mill Creek valley near the Dexter exit.
16.7	117.7	Junction with Rt. 23, head south on Rt. 23 (Toledo)

D.F.L.E.	A.M.	DESCRIPTION
8.5	126.2	Leave Rt. 23 at the Carpenter Road exit on the north side of Milan.
0.1	126.3	Turn left on Carpenter Rd.
0.4	126.7	Turn right on Arkona Rd.
1.5	128.2	Pull off road at quarry - landfill site

STOP NO. 9 - Martin-Marietta Quarry. This abandoned quarry exposed the Middle Devonian Silica Formation. You will be able to collect fossils from the dump material.

Return to Rt. 23 and head south to Toledo.

Monroe Street overpass.

Enter Oak Openings area, a long narrow oval stretching from Sylvania, Ohio to Grand Rapids, Ohio (25-30 miles). The soil here is composed mainly of a fine yellow sand. This area was once know as the Black Swamp, traversed in canoes by Indians and early settlers. The most extensive field tile drainage system in the world has developed this soil into valuable farm land.

Jct. with I-475. Proceed east on I-475, follow signs for the University of Toledo.